CHECK-LIST FOR NEW-MINERAL PROPOSALS (2005)

NOTE: Wherever numerical data are to be entered, the spaces are followed by brackets. Please give estimated errors or estimated standard deviations in the brackets. For example, *a* 12.345(9).

GENERAL INFORMATION

MINERAL NAME: **Rruffite**

CHEMICAL FORMULA: **$Ca_2Cu^{2+}(AsO_4)_2 \cdot 2H_2O$**
CRYSTAL SYSTEM: Monoclinic SPACE GROUP: $P2_1/c$ (#14)

POINT GROUP: (if space group is unknown)

a=5.8618(2) Å	*b*=12.7854(5) Å	*c*=5.7025(2) Å
α=90º	β=109.425(2)º	γ=90º
V=403.05(3) Å^3	Z = 2	

AUTHORS' NAMES AND **COMPLETE** ADDRESS (also e-mail for the corresponding author):

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OCCURRENCE: Give specific details on the geographic locality. In cases of remote localities, please give latitude and longitude.

Maria Catalina mine, Pampa Larga Mining District, Tierra Amarilla, Chile (latitude 22°3' S. and longitude 68°30' W.) (Parker et al. 1963).

ASSOCIATED MINERALS: Give the complete list. (see **Fig. 1** in the supplemental file)
Conichalcite $CaCuAsO_4(OH)$ (An untwined crystal was studied from this sample, see Henderson et al. 2008).
Mansfieldite $AlAsO_4 \cdot 2H_2O$
Barite $BaSO_4$
Alumopharmacosiderite $KAl_4(AsO_4)_3(OH)_4 \cdot 6.5H_2O$
Philipsbornite $PbAl_3(AsO_4)(AsO_3OH)(OH)_6$
Lavendulan $NaCaCu_5(AsO_4)_4Cl \cdot 5H_2O$
Barahonaite-(Al) $(Ca,Cu,Na,Fe^{3+},Al)_{12}Al_2(AsO_4)_8(OH,Cl)_x \cdot nH_2O$

ORIGIN OF THE MINERAL: Give any information on how the mineral was formed.

Similar to other associated minerals (conichalcite, mansfieldite, and metazeunerite), rruffite is considered as a secondary mineral as well and it forms in the oxidation zone of a Cu-As ore body.

APPEARANCE AND PHYSICAL PROPERTIES

GENERAL APPEARANCE: Give a short description including the kind of crystals or grains, the kind of aggregates, the size of individual grains or crystals (in metric units) and the size of aggregates.

Crystals are commonly in granular or blocky aggregates and druses (up to 0.05 x 0.05 x 0.05 mm). Twinning is common on (100).

PHYSICAL PROPERTIES

COLOUR (megascopic): Pale- or light-blue in transmitted light
STREAK: pale-blue to white (colour of the powder)

LUSTRE: vitreous: **X** adamantine ..... metallic ..... other .....
(specify)

OPAQUE ..... TRANSLUCENT ..... TRANSPARENT: **X**

FLUORESCENCE: none.....
(give colours and wavelengths of excitation)

HARDNESS:

Mohs: ~3.0

Micro-indentation: VHN load ..... g mean ..... range ..... kg/mm^2

CLEAVAGE: . {010} perfect.....
(directions and perfection)

PARTING: : None.....
(directions and perfection)

TENACITY: brittle: **X** sectile ..... malleable ..... other .....

FRACTURE: uneven

DENSITY (meas.): 3.79(3) g/cm^3 DENSITY (calc.): 3.77 (2) g/cm^3

Method used to measure density: heavy-liquid hydrous solution.

OTHER DATA: (Use additional pages, if necessary)

THERMAL:

INFRA RED:

OTHER: Raman spectra (see **Fig. 2 and Table 1** in the supplemental data file).

OPTICAL PROPERTIES

NONMETALLIC MINERALS: (Give estimated errors) WAVELENGTH = ... nm

ISOTROPIC: n ..... ( )

UNIAXIAL (+) (−): ω ..... ( ) ε ..... ( )

BIAXIAL (−) : α 1.725 (1) β 1.734 (1) γ 1.740 (1)

2V (meas.): -80(2)º 2V (calc.): -78º

DISPERSION: … r < v …; weak

ORIENTATION: (As complete as possible): $Y = b$, $X \wedge c = 49º$

PLEOCHROISM: none

METALLIC MINERALS

COLOUR (microscopic): .....

BIREFLECTANCE: .....

PLEOCHROISM: .....

ANISOTROPY: .....

INTERNAL REFLECTIONS: .....

REFLECTANCE VALUES (Measurements at the four wavelengths marked COM, below, are the *minimum* requirements):

Standard: ..... (It should be one of those recommended by the Commission on Ore Mineralogy, I.M.A.).

Measured in air? yes ..... no .....

Measured in oil? yes ..... no ..... (refractive index of oil: .....)

For multiple R values, please indicate: $R_{max.}/R_{min.}$, R_O/R_E, etc.

..... 400nm	..... 560nm
..... 420nm	..... 580nm
..... 440nm	..... 589nm (COM)
..... 460nm	..... 600nm
..... 470nm (COM)	..... 620nm
..... 480nm	..... 640nm
..... 500nm	..... 650nm (COM)
..... 520nm	..... 660nm
..... 540nm	..... 680nm
..... 546nm (COM)	..... 700nm

OTHER OPTICAL DATA

CHEMICAL DATA

TYPE OF ANALYSIS:

WET ….. ELECTRON MICROPROBE: **X** OTHER: .....

ELECTRON MICROPROBE: WDS/EDS; kV: 10; nA: 5; beam diameter: 20 μm

H_2O ANALYTICAL METHOD: by the combination of electron microprobe and X-ray structure data. The presence of water was also confirmed by the Raman spectroscopic measurements (see **Fig. 2a** in the supplemental file).

CO_2 ANALYTICAL METHOD .....

NOTE: If H_2O or CO_2 was not determined directly, give the reason(s). We did not have the access to other techniques. Furthermore, we have very few crystals available. However, we believe that the results from the combination of electron microprobe analysis and X-ray structure refinement can be justified.

ANALYTICAL RESULTS:

Number of analyses: 9
For multiple analyses please give ranges and standard deviations of the data.
Please give below the analytical data that conform to the material from which the physical, optical and crystal data were obtained.

Constituent	**Wt.%**	**Range**	**Stand. Dev.**	**Probe Standard**
As_2O_5	50.37	49.63-50.83	0.39	As metal
CaO	24.55	24.18-24.81	0.23	diopside
CuO	17.47	17.16-17.80	0.23	chalcopyrite
SO_3	0.11	0.04-0.16	0.04	chalcopyrite
Total	**92.50**	92.06-93.26	0.62	

(Trace amounts of Fe and Mg were also observed by WDS, but are under detection limits).

EMPIRICAL FORMULA: $Ca_{2.01}Cu_{1.01}(AsO_4)_{2.02}•1.9H_2O$

(GIVE BASIS OF CALCULATION, SUCH AS NUMBER OF ANIONS, ETC.):
The number of oxygen atoms bonded to As^{5+}, which is 4.
SIMPLIFIED FORMULA: $Ca_2Cu(AsO_4)_2•2H_2O$

CHEMICAL TESTS (etching, solution):

CRYSTALLOGRAPHY

SINGLE-CRYSTAL STUDY:

METHOD: Precession ..... Weissenberg ..... 4-circle: **X**. Other .....

NOTE: If no single-crystal study was done, explain why.

CRYSTAL SYSTEM: Monoclinic

SPACE GROUP: $P2_1/c$ (#14) POINT GROUP (if space group is unknown): .....

CELL PARAMETERS:

a= 5.8618 (2) Å	α =90º
b= 12.7854 (5) Å	β =109.425(2)º
c= 5.7025(2) Å	γ = 90º
V =403.05(3) Å^3	Z = 2

POWDER DATA: (For CuKα: X, FeKα ……)

Debye-Scherrer ..... Gandolfi ..... Diffractometer: Bruker APEX2 **(**MoKα) Guinier .....

Diameter of camera .....… mm

CELL PARAMETERS REFINED FROM POWDER DATA? YES: X NO .....

CRYSTAL SYSTEM: Monoclinic

SPACE GROUP: .....….. POINT GROUP (if space group is unknown): .....

a= 5.892 (5) Å	α =90º
b= 12.724 (8) Å	β =109.28(9)º
c= 5.722(4) Å	γ = 90º
V =404.9(4) Å^3	Z = 2

ON A SEPARATE PAGE PLEASE SUPPLY THE **COMPLETE** X-RAY POWDER DIFFRACTION DATA AS SHOWN BELOW.

GIVE IN **BOLD** THE INTENSITIES OF THE STRONGEST LINES.

I	$d_{meas.}$	$d_{calc.}$	hkl

(see Figure 3 and **Table 2** in the supplemental data file)

CRYSTAL STRUCTURE: (Summarize the details)

R_1 = 0.023, *wR*=0.060 **(see Table 3 in the supplemental data file)**

The structure of rruffite is isostructural with roselite (Hawthorne and Ferguson 1977) and characterized by isolated $CuO_4(OH2)_2$ octahedra that are linked by corner-sharing with AsO_4 tetrahedra to form chains extending parallel to the *c*-axis (**Fig. 4**). These chains are linked together by the large Ca cations and hydrogen bonding. The Ca cations are 7-coordinated (6 O^{2-} + 1 H_2O). The $CuO_4(OH2)_2$ octahedra are noticeably elongated, due to the strong Jahn-Teller effect, similar to that found in krhnkite $Na_2Cu^{2+}(SO_4)_2 \bullet 2H_2O$ (Hawthorne and Ferguson 1975).

MORPHOLOGY:

HABIT: commonly in granular or blocky aggregates and druses.

FORMS: dominated by {100}, {110}, {120}, {010}

TWINNING: on {010}, perfect

OTHER DATA: a:b:c: 0.458:1.000:0.446 (from unit-cell parameters)

MISCELLANEOUS DATA

NAME: If named for a living person, indicate his or her acceptance and year of birth. If named for a deceased person, please give years of birth and death. For names transliterated from the Cyrillic alphabet, please give the original Cyrillic spelling.
Explain the reason for selecting the name.

The mineral name, rruffite, is proposed in honor of the RRUFF project --- the first **Internet-based, internally-consistent, and integrated** database of Raman spectra, X-ray diffraction, and chemistry data for minerals. The project has more than 3000 minerals in the database now and has provided a standard for mineralogists, geoscientists, materials scientist, and the general public for the identification of minerals and inorganic materials. All data in the RRUFF project are free-accessible on the Internet (***http://rruff.info***). Rruffite was discovered in the course of identifying minerals for the project, which involved the efforts from many people, including undergraduate and graduate students, post-doctoral research fellows, and project scientists. **Figure 5** is a photo of people working in the RRUFF project in 2008. We understand that it is not common to name a mineral after a research project or a group, but it is not with precedence. For example, the concept of naming this mineral is similar to that of naming the mineral “grumiplucite” in honor of the amateur mineralogical group Gruppo Mineralogico e Paleontologico Lucchese, which provided the specimens for the study (Orlandi et al. 1998), or the mineral “minrecordite”, which was proposed in honor of the magazine “the Mineralogical Record”.

TYPE MATERIAL: Give the name and the address of the museum where it is deposited. Only professionally curated museums are acceptable. **Give the catalogue number(s) of the material.** State explicitly whether holotype or cotype specimens were used.

Holotype: a single specimen (designated by the author) from which **all the data** for the original description were obtained. Where portions of such a specimen have been sent to other museums for preservation, the **author** will designate each of these as "part of the holotype".

Cotype: specimens (designated by the author) as those used to obtain quantitative data for the original description. Specimens examined only visually should **not** be considered cotypes.

Part of the holotype sample has been deposited at the Mineral Museum of the University of Arizona (Catalogue # 18813).

RELATIONSHIP TO OTHER SPECIES: Include, if possible, where the species fits into a mineral classification (e.g., Nickel & Strunz, Dana).

If the mineral is similar to other minerals, please provide a table (on a separate page) comparing the following data for all the species involved: chemical formula, crystal system, space group, unit-cell parameters, strongest lines in the powder pattern, optical data and any other data which will help to differentiate the species from the related species.

Rruffite belongs to the roselite family and is isostructural with roselite and many other minerals (see **Table 4** in the supplemental data file).

REFERENCES: Please give full reference data to all pertinent material.

Garavelli C G, Vurro F, Fioravanti G C (1982) Minrecordite a new mineral from Tsumeb, The Mineralogical Record 13, 131-136

Hawthorne, F.C. and Ferguson, R.B. (1975) Refinement of the crystal structure of kröhnkite, Acta Crystallographica, B31, 1753-1755.

Hawthorne, F.C. and Ferguson, R.B. (1977) The crystal structure of roselite, The Canadian Mineralogist, 15, 36-42.

Henderson R R, Yang H, Downs R T, Jenkins R A (2008) Redetermination of conichalcite, $CaCu(AsO_4)(OH)$, Acta Crystallographica, E64, i53-i54.

Orlandi P, Dini A, Olmi F (1998) Grumiplucite, a new mercury - bismuth sulfosalt species from the Levigliani Mine, Apuan Alps, Tuscany, Italy, The Canadian Mineralogist 36, 1321-1326

Parker, R.L., Salas, R.O., and Perez, G.R. (1963) Geologia de los distritos mineros Checo de Cobre Pampa Larga y Cabeza de Vaca. Instituto de Investigaciones Geologicas (Chile), 14, 40-42.

COMPATIBILITY $(1-K_P/K_C) = 0.026$ (Excellent). If fair or poor, explain reason(s).
($K_P = 0.194$, $K_C = 0.189$, $n = 1.733$, $d_{cal.} = 3.77$)

AUTHORS' REMARKS:

Add anything which will clarify difficult parts of the description. If your remarks are long and you would like all the members of the Commission to see them, please type them single-spaced on additional pages.

IMPORTANT NOTICE: Please provide all data (this check-list, any additional pages, tables and figures) in electronic file(s), preferably in Word format, as the communication within the CNMMN is completely in electronic format.

SUPPLEMENTAL DATA FOR THE MINERAL RRUFFITE

Figure 1a. A piece of rock on which rruffite crystals, along with conichalcite, mansfieldite, barite, alumopharmacosiderite, and philipsbornite are found.

Figure 1b. A close view of rruffite (pale blue) and conichalcite (green) crystals.

Figure 2a. Raman spectrum of rruffite in the range of 100-3800 cm^{-1}.
(Raman spectra of rruffite were collected on a randomly oriented crystal from 9 scans at 30 s and 100% power per scan on a Thermo Almega microRaman system, using a solid-state laser with a frequency of 532 nm and a thermoelectric cooled CCD detector. The laser is partially polarized with 4 cm^{-1} resolution and a spot size of 1 μm.)

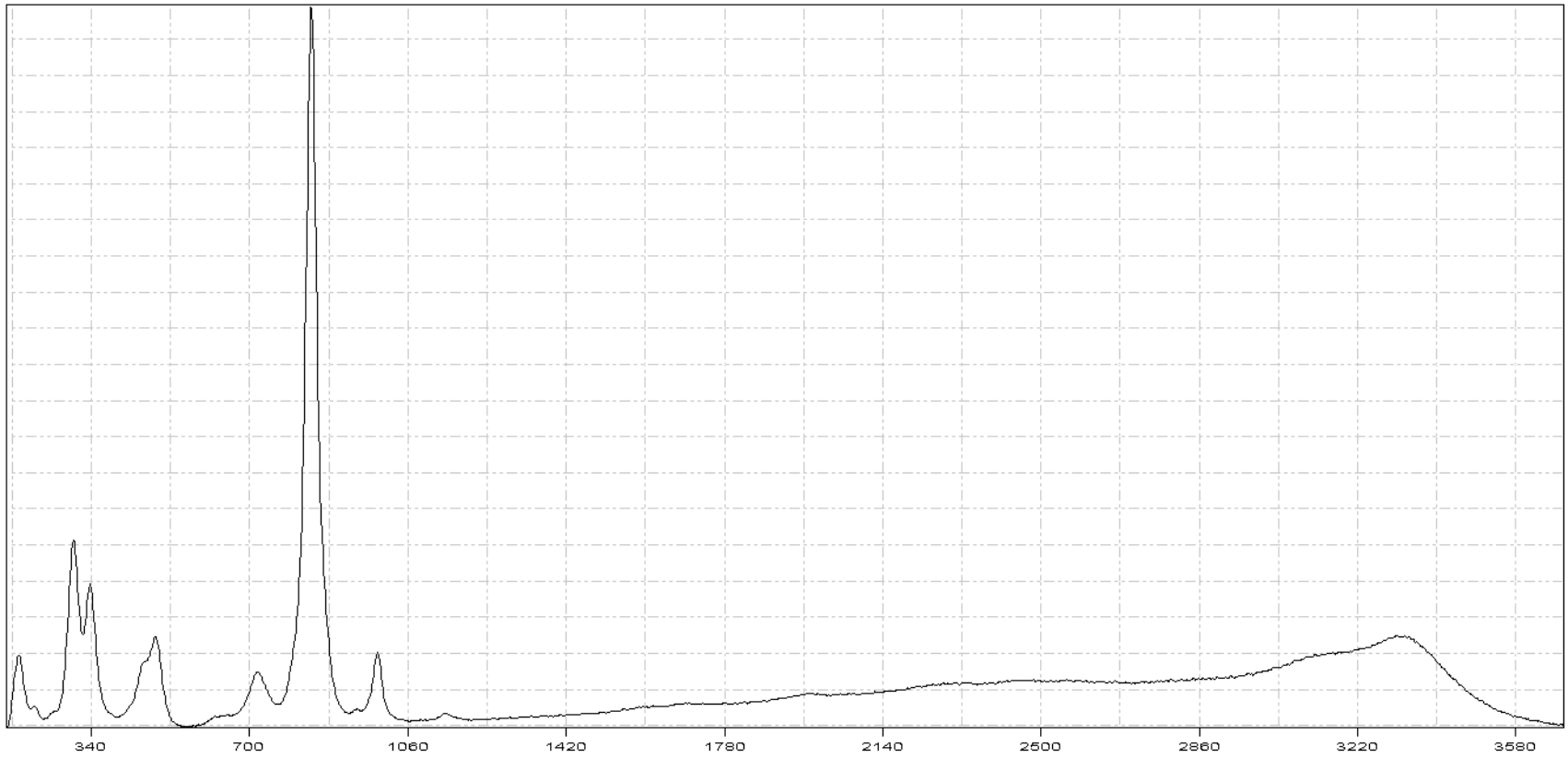

Figure 2b. Raman spectrum of rruffite in the range of 100-1200 cm^{-1}.

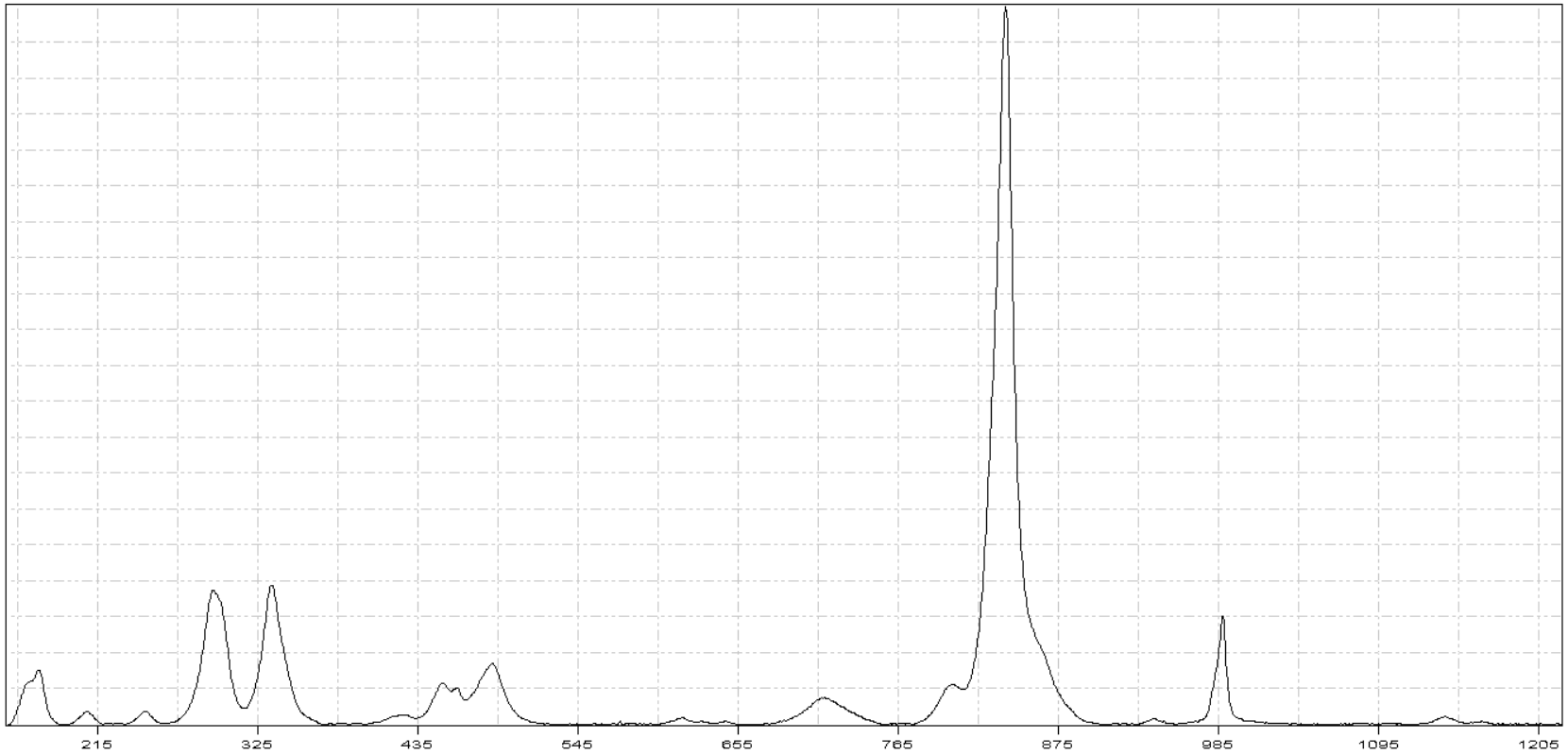

Table 1. Raman spectrum of rruffite and tentative band assignments

Bands(cm^{-1})	Intensity	Assignment
3335, 3147	Weak, broad bands	Water ν_1- ν_3 sym- and anti-symmetric stretching
866, 803, 715	Weak bands	ν_3 (AsO_4) anti-symmetric stretching
839	Very strong, sharp	ν_1 (AsO_4) symmetric stretching
617	Very weak	Water–water H bonding
487, 459, 426	Relatively strong, sharp	ν_4 (AsO_4) anti-symmetric bending
335, 296	Strong, sharp	ν_2 (AsO_4) symmetric bending
260-150	Relatively strong, sharp	Lattice vibrational modes and Cu-O and Ca-O interactions

Fig. 3a. Powder X-ray diffraction data collected on Bruker APEX2 (MoK_α)

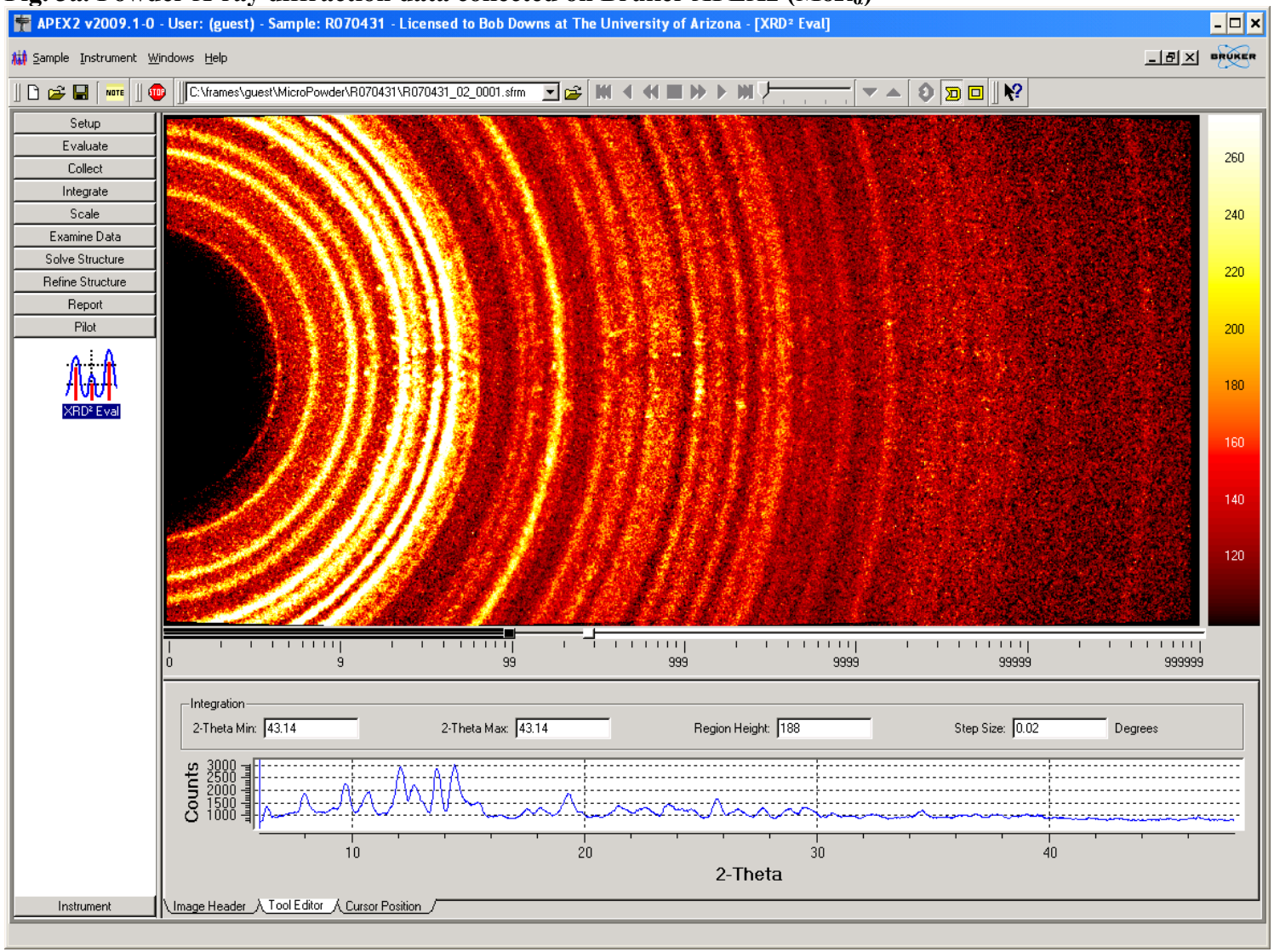

Fig. 3b. Integrated powder diffraction data (black line—experimental result; blue line –theoretical result).

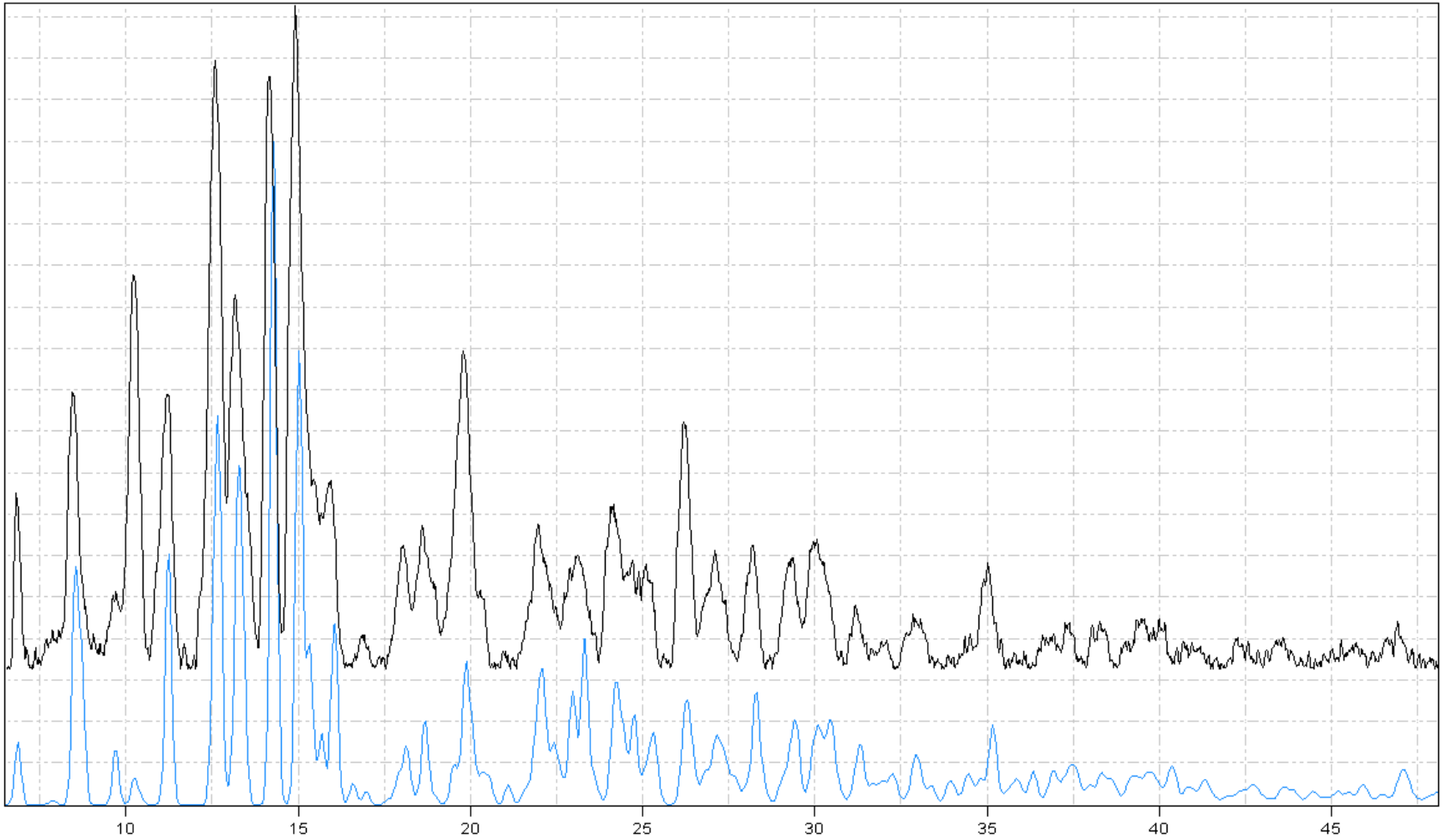

Table 2. Powder X-ray diffraction data for rruffite

[Measured on a Bruker APEX2 CCD X-ray diffractometer equipped with graphite-monochromatized MoK_{α} radiation ($\lambda = 0.71069$Å)]

Intensity	$d_{meas.}$	$d_{calc.}$	h	k	l
27	6.400	6.362	0	2	0
42	5.087	5.096	1	1	0
11	4.425	4.436	-1	1	1
59	4.177	4.187	1	2	0
41	3.800	3.798	-1	2	1
92	3.377	3.373	1	3	0
56	3.190	3.181	0	4	0
89	2.983	2.971	1	2	1
100	2.827	2.823	-1	0	2
28	2.750	2.756	-1	1	2
28	2.643	2.632	-2	2	1
19	2.344	2.350	-1	3	2
22	2.240	2.241	-1	5	1
49	2.114	2.111	-1	4	2
22	1.898	1.899	-2	4	2
15	1.830	1.827	-1	2	3
17	1.793	1.793	1	6	1
25	1.732	1.732	0	2	3
15	1.701	1.699	3	3	0
16	1.659	1.657	0	3	3
37	1.595	1.591	-3	4	2
11	1.564	1.566	-3	1	3
18	1.537	1.539	-2	7	1
10	1.524	1.528	-1	7	2
19	1.483	1.485	2	4	2
17	1.430	1.431	-4	2	1
19	1.383	1.386	-1	8	2
12	1.376	1.376	-2	6	3
9	1.340	1.339	-2	3	4

8	1.269	1.270	-2	9	1
16	1.193	1.190	1	10	1

Table 3. Structure refinement results for rruffite

ATOM	x	y	z	sof	U11	U22	U33	U23	U13	U12	Ueq
Cu1	0.00000	0.00000	0.00000	0.50000	0.01093	0.01209	0.01356	-0.00444	0.00155	0.00010	0.01282
	0.00000	0.00000	0.00000	0.00000	0.00020	0.00019	0.00021	0.00016	0.00016	0.00015	0.00011
Ca1	0.56418	0.12303	0.21155	1.00000	0.00887	0.00936	0.01194	-0.00099	0.00376	-0.00026	0.00998
	0.00009	0.00004	0.00009	0.00000	0.00021	0.00019	0.00021	0.00016	0.00017	0.00015	0.00010
As1	0.22626	0.12128	0.54652	1.00000	0.00736	0.00759	0.00840	-0.00009	0.00192	0.00015	0.00795
	0.00004	0.00002	0.00004	0.00000	0.00012	0.00011	0.00012	0.00008	0.00008	0.00008	0.00008
O1	0.95325	0.17490	0.48155	1.00000	0.00831	0.01263	0.01417	0.00013	0.00201	0.00414	0.01213
	0.00031	0.00014	0.00035	0.00000	0.00074	0.00075	0.00083	0.00064	0.00066	0.00060	0.00034
O2	0.30179	0.05416	0.81485	1.00000	0.01235	0.01037	0.01064	0.00256	0.00370	0.00106	0.01115
	0.00032	0.00013	0.00033	0.00000	0.00080	0.00071	0.00078	0.00061	0.00065	0.00060	0.00033
O3	0.23809	0.03793	0.31832	1.00000	0.01023	0.01353	0.01175	-0.00479	0.00322	-0.00060	0.01194
	0.00032	0.00014	0.00034	0.00000	0.00078	0.00076	0.00081	0.00064	0.00065	0.00062	0.00034
O4	0.44679	0.20667	0.54960	1.00000	0.01144	0.01157	0.01564	-0.00241	0.00557	-0.00488	0.01262
	0.00032	0.00014	0.00035	0.00000	0.00077	0.00073	0.00086	0.00065	0.00068	0.00062	0.00035
O5w	0.82611	0.13610	0.95589	1.00000	0.01115	0.00948	0.01050	-0.00106	0.00038	-0.00092	0.01118
	0.00035	0.00014	0.00035	0.00000	0.00080	0.00072	0.00078	0.00063	0.00065	0.00061	0.00034
H1	0.89726	0.19718	0.98318	1.00000	0.04000						
	0.00706	0.00344	0.00821	0.00000	0.00000						
H2	0.73086	0.14106	0.85527	1.00000	0.04000						
	0.00747	0.00347	0.00900	0.00000	0.00000						

Note:
(1) The numbers in second line following each atom are e.s.d. for each parameters.
(2) The refinement was conducted using SHELX97.

(3) Isotropic displacement parameters of all H atoms were fixed to 0.04 during the final refinement.
(4) 2θ = 68.6°.Total reflections collected = 5736, independent reflections = 1658, observed independent reflections = 1435.
Parameters refined = 77, R_{int} = 0.23, R1=0.023, wR=0.060

Figure 4. Crystal structure of rruffite. Yellow octahedra = $CuO_4(OH)2$, purple tetrahedra = AsO4, white spheres = Ca cations, and light blue spheres = H atoms.

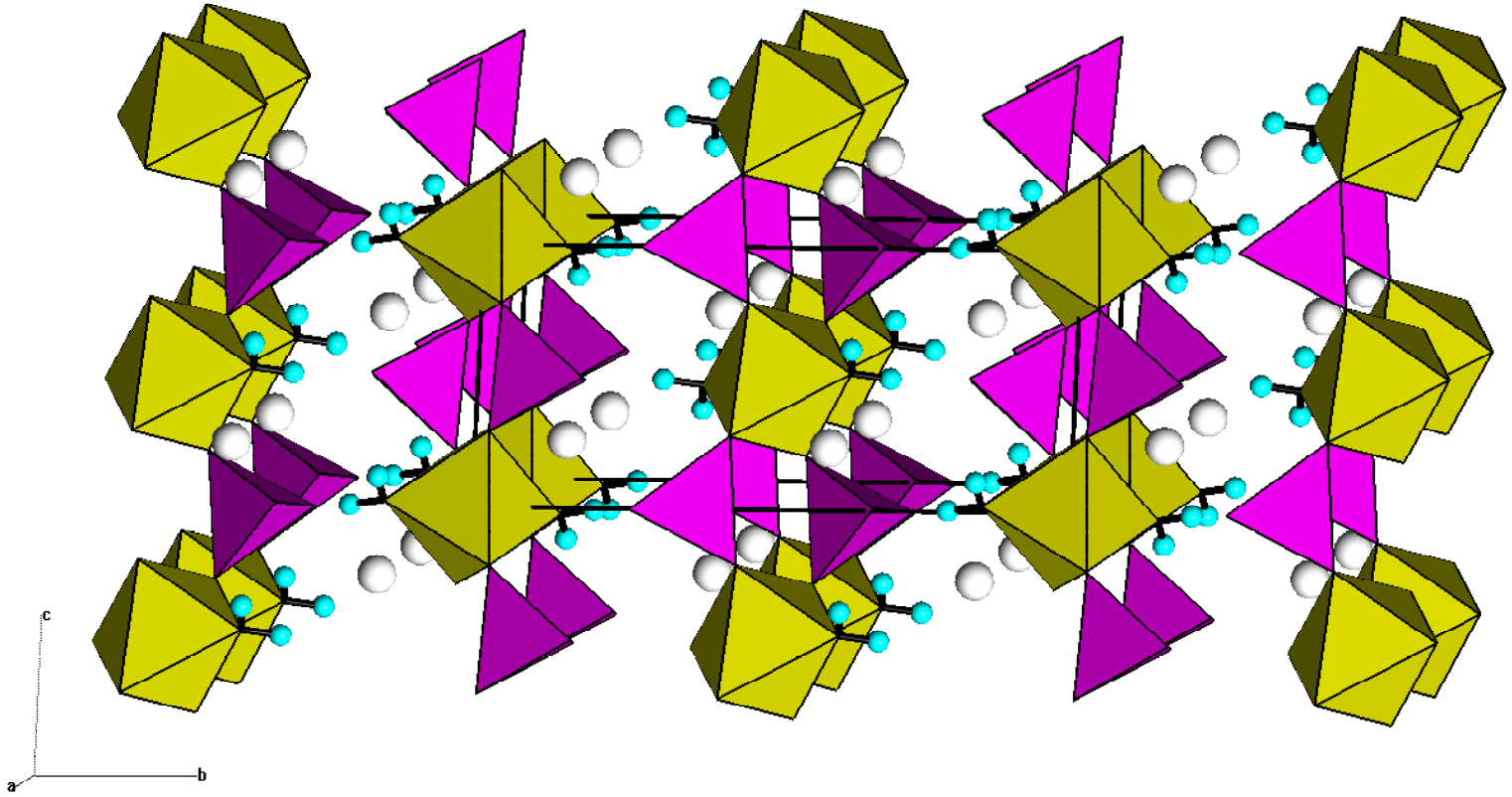

Figure 5. A photo of people working in the RRUFF project in 2008.

Table 4. Rruffite and related minerals

Rruffite	**$Ca_2Cu^{2+}(AsO_4)_2{\cdot}2H_2O$**	**5.86**	**12.78**	**5.70**	**90**	**109.4**	**90**	**$P2_1/c$**
Roselite	$Ca_2Co(AsO_4)_2{\cdot}2H_2O$	5.80	12.90	5.62	90	107.4	90	$P2_1/c$
Kröhnkite	$Na_2Cu^{2+}(SO_4)_2{\cdot}2H_2O$	5.81	12.66	5.52	90	108.3	90	$P2_1/c$
Wendwilsonite	$Ca_2Mg(AsO_4)_2{\cdot}2H_2O$	5.81	12.92	5.63	90	107.5	90	$P2_1/c$
Zincroselite	$Ca_2Zn(AsO_4)_2{\cdot}2H_2O$	5.83	12.90	5.65	90	107.7	90	$P2_1/c$
Brandtite	$Ca_2Mn^{2+}(AsO_4)_2{\cdot}2H_2O$	5.88	12.96	5.67	90	108	90	$P2_1/c$
Lazulite	$Al_2Mg(PO_4)_2(OH)_2$	7.14	7.28	7.23	90	120.5	90	$P2_1/c$
Scorzalite	$Al_2Fe^{2+}(PO_4)_2(OH)_2$	7.15	7.31	7.25	90	120.6	90	$P2_1/c$
Barbosalite	$Fe^{3+}{}_2Fe^{2+}(PO_4)_2(OH)_2$	7.33	7.49	7.41	90	118.4	90	$P2_1/n$
Hentschelite	$Fe^{3+}{}_2Cu(PO_4)_2(OH)_2$	6.98	7.79	7.27	90	117.7	90	$P2_1/n$
Wilhelmkleinite	$Fe^{3+}{}_2Zn(AsO_4)_2(OH)_2$	6.63	7.61	7.38	90	91.8	90	$P2_1/n$
Lindgrenite	$Cu_3(Mo^{6+}O_4)_2(OH)_2$	5.39	14.02	5.608	90	98.50	90	$P2_1/n$
Drugmanite	$Pb_2Fe^{3+}(PO_4)(HPO_4)(OH)_2$	11.11	7.99	4.64	90	90.4	90	$P2_1/a$
Talmessite	$Ca_2Mg(AsO_4)_2{\cdot}2H_2O$	5.87	6.94	5.54	97.3	108.7	108.1	P-1
beta-roselite	$Ca_2Co(AsO_4)_2{\cdot}2H_2O$	5.88	6.98	5.56	97.3	108.9	108.2	P-1
Gaitite	$Ca_2Zn(AsO_4)_2{\cdot}2H_2O$	5.90	6.98	5.58	97.4	109.1	108.1	P-1
fairfieldite	$Ca_2Mn^{2+}(PO_4)_2{\cdot}2H_2O$	5.80	6.58	5.50	102.4	108.6	90.3	P-1
collinsite	$Ca_2Mg(PO_4)_2{\cdot}2H_2O$	5.73	6.78	5.44	97.3	108.6	107.3	P-1
Gartrellite	$PbCuFe^{3+}(AsO_4)_2(OH){\cdot}H_2O$	5.43	5.64	7.57	67.6	69.6	70.3	P-1
Zincgartrellite	$PbZn_2(AsO_4)_2{\cdot}2H_2O$	5.55	5.62	7.62	68.6	69.2	69.5	P-1
Phosphogartrellite	$PbCuFe^{3+}(PO_4)_2{\cdot}(OH)_2$	5.32	5.53	7.43	67.6	69.7	70.7	P-1
lukrahnite	$CaCuFe^{3+}(AsO_4)_2(OH)_2$	6.35	9.80	6.30	84.5	106.4	96.4	P-1
Parabrandtite	$Ca_2Mn^{2+}(AsO_4)_2{\cdot}2H_2O$	5.89	7.03	5.64	96.8	109.3	108.5	P1
Rappoldite	$Co_2Pb(AsO_4)_2{\cdot}2H_2O$	11.19	10.55	7.59	100.4	109.6	99.0	P-1
C2/m subcell		9.19	6.34	7.59	90	114.2	90	C2/m
Warikahnite	$Zn_3(AsO_4)_2{\cdot}2H_2O$	6.71	8.99	14.53	105.6	93.4	108.7	P-1
Cassidyite	$Ca_2Ni(PO_4)_2{\cdot}2H_2O$	5.71	6.73	5.41	96.8	107.4	104.6	P-1
Hillite	$Ca_2Zn(PO_4)_2{\cdot}2H_2O$	5.74	6.77	5.46	97.4	108.6	107.2	P-1
Jagowerite	$Al_2Ba(PO_4)_2(OH)_2$	6.05	6.96	4.97	116.5	86.1	112.6	P-1

Messelite	$Ca_2Fe^{2+}(PO_4)_2 \cdot 2H_2O$	5.48	5.76	6.57	90.2	102.6	108.5	P-1
cabalzarite	$Mg_2Ca(AsO_4)_2 \cdot 2H_2O$	8.93	6.14	7.35	90	115.3	90	C2/m
Nickelschneebergite	$Ni_2Bi(AsO_4)_2(OH) \cdot H_2O$	9.00	6.21	7.46	90	115.0	90	C2/m
Schneebergite	$Co_2Bi(AsO_4)_2(OH) \cdot H_2O$	9.01	6.21	7.44	90	115.2	90	C2/m
Cobaltlotharmeyerite	$Co_2Ca(AsO_4)_2 \cdot 2H_2O$	9.03	6.24	7.43	90	115.2	90	C2/m
Manganlotharmeyerite	$Mn^{3+}{}_2Ca(AsO_4)_2(OH)_2$	9.04	6.23	7.39	90	116.4	90	C2/m
Nickellotharmeyerite	$Ni_2Ca(AsO_4)_2 \cdot 2H_2O$	9.04	6.23	7.40	90	115.3	90	C2/m
Lotharmeyerite	$Zn_2Ca(AsO_4)_2(OH)_2$	9.07	6.28	7.41	90	116.2	90	?
Mawbyite	$Fe^{3+}{}_2Pb(AsO_4)_2(OH)_2$	9.07	6.29	7.56	90	114.8	90	C2/m
thometzekite	$Cu^{2+}{}_2Pb(AsO_4)_2 \cdot 2H_2O$	9.08	6.30	7.66	90	117.0	90	C2/m
Cobalttsumcorite	$Co_2Pb(AsO_4)_2 \cdot 2H_2O$	9.10	6.32	7.57	90	115.0	90	C2/m
Tsumcorite	$PbZnFe(AsO_4)_2(OH) \cdot H_2O$	9.12	6.33	7.58	90	115.3	90	C2/m
Mounanaite	$Fe^{3+}{}_2Pb(VO_4)_2(OH)_2$	9.29	6.17	7.71	90	115.6	90	C2/m
Natrochalcite	$Cu_2Na(SO_4)_2(OH) \cdot H_2O$	8.81	6.19	7.51	90	118.7	90	C2/m
Sewardite	$Fe^{3+}{}_2Ca(AsO_4)_2(OH)_2$	16.46	7.43	12.13	90	90	90	Cccm
Carminite	$Fe^{3+}{}_2Pb(AsO_4)_2(OH)_2$	16.60	7.58	12.30	90	90	90	Cccm
Rouseite	$Pb_2Mn^{2+}(AsO_3)_2 \cdot 2H_2O$	6.36	7.29	5.54	97.3	114.2	106.0	P-1
Afwillite	$Ca_3(HSiO_4)_2 \cdot 2H_2O$	16.28	5.63	13.24	90	134.9	90	Cc
Attakolite	$CaMn^{2+}Al_4(HSiO_4)(PO_4)_3(OH)_4$	17.19	11.48	7.32	90	113.8	90	C2/m
Cuprotungstite	$Cu_3(WO_4)_2(OH)_2$	8.93	8.93	14.48	90	90	90	$P4_32_12$
Lipscombite	$Fe^{3+}{}_2Fe^{2+}(PO_4)_2(OH)_2$	7.31	7.31	13.21	90	90	90	$P4_32_12$
Zinclipscombite	$Fe^{3+}{}_2Zn(PO_4)_2(OH)_2$	7.24	7.24	13.13	90	90	90	$P4_32_12$
Petitjeanite	$Bi_3(PO_4)_2O(OH)$	9.80	7.25	6.87	88.3	115.3	110.7	P-1
Schumacherite	$Bi_3(VO_4)_2O(OH)$	10.05	7.46	6.90	87.7	115.3	111.5	P-1
Scholzite	$Zn_2Ca(PO_3)_2 \cdot 2H_2O$	17.15	7.41	6.67	90	90	90	Pbcn